DATA COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a data communication system that is provided with one main station and one or a plurality of substations, and more particularly to a data communication system for broadcast communications from the main station to the substations.

Description of Related Art

Before now, data communication systems having one main station and one or a plurality of substations were known. These data communication systems are systems for broadcast communication from a main station to the substations. Broadcast communication is communication wherein data addressed to one or a plurality of substations are transmitted from one main station. With broadcast communication, the same data can be transmitted to one or a plurality of substations substantially at the same time. In the case of effecting broadcast communication, the main station queries the substations as to whether the data were received normally once a prescribed quantity of data is transmitted. This query operation is generally called polling. Polling methods are disclosed in "Information communications protocol", Tadao Saito and Mitsuhiro Ishizaka, pp. 73, Ohm Co., for example.

In polling by a conventional data communication system, the main station queries each substation individually as to

whether the data were received normally. For this reason, the main station must perform the query operation for the same times as the number of substation that received the data. Consequently, when a large number of substations received data, the query operation is performed many times and the data communication becomes inefficient.

SUMMARY OF THE INVENTION

It is an object of the present invention to improve data communication efficiency by simplifying polling in broadcast communication.

In order to achieve this object, the data communication system relating to the present invention comprises the following: means for transmitting data addressed to all substations provided in the main station; means for receiving data provided in the substations; means for transmitting a message addressed to all substations after data are transmitted, to inquire whether reception was normal, provided in the main station; and means for transmitting a response message to the query message, only when said data could not be received normally, provided in the substations.

The time for confirming whether transmission was normal can be shortened by the main station transmitting data addressed to all substations, and the substations transmitting a response message only in the event of abnormal reception.

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BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention are explained with reference to the following appended drawings.

Figure 1 is a block diagram showing an example constitution of a communication system relating to the present invention; and

Figures 2 and 3 show timing charts for explaining the data communication procedure relating to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The embodiments of the present invention are explained below using the drawings. In the drawings, the sizes, forms, and positional relationships among the structural elements are merely to aid in the understanding of the present invention. Moreover, the numerical conditions in the following explanation are merely a simple illustration.

Figure 1 is a block diagram showing the constitution of a communications system relating to the present embodiment.

As shown in Figure 1, this communication system comprises one main station 101 and a plurality of substations 102, 103, 104 that are connected by a common transmission line 105.

The main station 101 transmits a prescribed quantity of data on the transmission line 105. The main station 101 then transmits a message, for inquiring whether the

transmitted data were received normally, on the transmission line 105. Then, in the case where a response message is received from the transmission line 105 within a prescribed period of time from the transmission of this query message, the previously transmitted data are transmitted another time. On the other hand, when a response message is not received within the prescribed time period, the next data are transmitted.

The substations 102 - 104 receive data from the transmission line 105 and then, after receiving the data, receive the query message from the transmission line 105. After receiving data, the substations 102 - 104 determine whether data were received normally or abnormally. In the case of abnormally received data, the substations 102 - 104 transmit a response message on the transmission line 105 when the query message is received from the transmission line 105. In the case of normally received data, however, response messages are not sent.

Next, the basic communication procedures of the data communication system shown in Figure 1 are explained.

Figure 2 is a timing chart for explaining the communication procedures.

The main station 101 effects message transmission and reception synchronized with the period T slot clock. Consequently, times t1 - t5 discussed below are given by the leading edge or trailing edge of the slot clock.

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At the time t1, the main station 101 transmits the first transmission data D1. This transmission data D1 reaches each substation 102 - 104 via the transmission line 105. The substations 102 - 104 thereby receive the same data D1 at essentially the same time.

At time t2, the main station 101 transmits the query message PA1 regarding the transmission data D1. This query message PA1 is addressed to all substations 102 - 104. The query message PA1 reaches each of the substations 102 - 104 via the transmission line 105.

The main station 101 effects carrier sensing during the time from the transmission of the query message PA1 until the next transmission time t3. As discussed above, the substations 102 - 104 return a response message or carrier in the case where data reception was abnormal, but do not return a response message when data reception was normal. In the example in Figure 2, the main station 101 determines that the transmission data were received normally by all substations 102 - 104 because the response message was not received by time t3.

Consequently, the main station 101 transmits the next transmission data D2 on transmission line 105 at time t3. The transmission data D2 reach all substations 102 - 104 via the transmission line 105.

At time t4, main station 101 transmits the query message PA2 for the transmission data D2 on the transmission line 105. The query message PA2 reaches each

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of the substations 102 - 104 via the transmission line 105. The main station 101 effects carrier sensing during the time from the transmission of the query message PA2 until the next transmission time t5.

In the example in Figure 2, the main station 101 detects response messages N1, N2, or carriers, generated from substations 103, 104. With the detection thereof, the main station 101 confirms that reception errors occurred in at least one substation.

Consequently, the main station 101 sends the transmission data D2 once again at time t5. The transmission data D2 are received by substations 102 - 104 via the transmission line 105. The substation 102 received the data D2 normally at the previous transmission. Consequently, the substation 102 scraps this transmission data D2. Meanwhile, the substations 103 and 104 take up the transmission data D2 because they were unable to receive the data D2 normally at the previous transmission.

In this data communication system, as explained above, the main station 101 is constituted so as to transmit query messages addressed to all substations 102 - 104, and the substations 102 - 104 are constituted so as to send response messages only when reception errors occur. Consequently, the time required to confirm reception becomes short even when there is a large number of substations. Consequently, the efficiency of data communication can be improved.

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The procedures for when the data communication system shown in Figure 1 is interrupted during communication are explained next.

Figure 3 is a timing chart for explaining the communication procedures. Figure 3 shows an example of the case where the same data are resent twice by the main station 101.

The main station 101 sends the transmission data D3 at time t6. The transmission data D3 reach the substations 102 - 104 via the transmission line 105. The substations 102 - 104 thereby receive the same data D3 at essentially the same time.

The main station 101 transmits the query message PA3 for the transmission data D3 at time t7. This query message PA3 is addressed to all substations 102 - 104. The query message PA3 reaches each substation 102 - 104 via the transmission line 105.

The main station 101 effects carrier sensing during the time from the transmission of the query message PA3 until the next transmission time t8. At this time, in the example in Figure 3, the main station 101 detects a response message N3 generated by substation 103. With the detection thereof, the main station 101 determines that a reception error occurred in at least one substation.

Consequently, the main station 101 sends the transmission data D3 once more at time t8. This transmission data D3 is received by the substations 102 -

104 via the transmission line 105. Because the substations
102 and 103 received the data D3 normally at the previous
transmission, they scrap this transmission data D3.
Meanwhile, the substation 104 takes up the received data D3
because the substation 104 was unable to receive the data
D3 normally at the previous transmission.

At time t9, the main station 101 transmits the query
message PA4 regarding the transmission data D3. This query
message PA4 is addressed to all substations 102 - 104. The
query message PA4 reaches each substation 102 - 104 via the
transmission line 105.

The main station 101 effects carrier sensing until the
next transmission time t10. At this time, in the example in
Figure 3, the main station 101 detects a response message
N4 generated by the substation 103.

The main station 101 sends the transmission data D3 a
third time at time t10. The transmission data D3 is
received by the substations 102 - 104 via the transmission
line 105. Because the substations 102 and 103 received the
data D3 normally at the previous transmission, they scrap
this transmission data D3. Meanwhile, the substation 104
takes up the received data D3 because the substation 104
was unable to receive the data D3 normally at the previous
transmission.

At time t11, the main station 101 transmits the query
message PA5 regarding the transmission data D3. This query
message PA5 is addressed to all substations 102 - 104. The

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query message PA5 reaches each substation 102 - 104 via the transmission line 105.

The main station 101 effects carrier sensing until the next transmission time t12. At this time, in the example in Figure 3, the main station 101 detects a response message N5 generated by the substation 103. However, because the same data D3 have now been resent twice, the main station 101 terminates transmission of the data D3 and transmits the next data D4 at time t12. The main station 101 then transmits a query message PA6 regarding the transmission data D4 at time t13.

As explained above, in this data communication system, re-transmission is terminated when the same data have been resent twice, even if one or more substations which has been unable to receive the data normally are exist. Consequently, it does not become impossible to update all the substations, even if some substations can not received the data normally.

In the embodiment discussed above, an example with a plurality of substations was used, but this can be applied to a data communication system with only one substation.

In the embodiment discussed above, data are resent a maximum of two times, but this maximum may be one time, or three or more times. Furthermore, this maximum can be freely changed by the data communication system administrator depending on conditions.